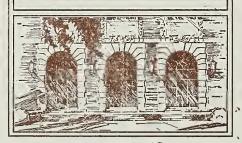




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1980 POPULATION PROJECTIONS FOR THE CITY OF CHICAGO

bу

Bruno Trapikas

September 27, 1974

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1980 POPULATION PROJECTIONS FOR THE CITY OF CHICAGO

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Center for Advanced Computation
University of Illinois at Urbana-Champaign
Urbana, Illinois, 61801

September 27, 1974



PREFACE

This study is intended to provide an outline of the probable population composition in the city of Chicago for the immediate future. It will also provide the framework for building similar models of population projection. It is hoped that it will be useful in determining the future characteristics of the city; the reader should remember, however, that the projections are estimates, subject to standard errors. The forecast was the result of both statistical processes and judgment; it was the transformation of a countless number of numbers into a new set of numbers.

The study was written for the Center for Advanced Computation, at the University of Illinois at Urbana, under contract from the Mayor's Office of Manpower, City of Chicago. It was also written in partial fulfillment of the requirements for the degree of Master of Arts in Quantitative Economics at the University of Illinois at Chicago Circle.

During the work on the project, many individuals provided helpful contributions. I would like to thank Professor Richard Kosobud of the University of Illinois at Chicago Circle, who served as my advisor during the course of the project, for his guidance and assistance. I would also like to thank Professor Hugh Folk, Director of the Center for Advanced Computation, and Mr. Thomas P. Milke, Research Programmer at the Center, for their assistance. Mr. Dennis McAvoy, at the Mayor's Office of Manpower, was also very helpful in providing assistance and useful commentary. Further, I would like to express my gratitude to Professors H. Woods Bowman and John McDonald of the University of



Illinois at Chicago Circle, for their very useful comments and suggestions. In the gathering of unpublished data, Mr. Henry Stanton, Director of Registration and Statistical Services, Chicago Board of Health, Professor Jean Margret Hynes, Systems Manager, Chicago Area Geographic Information Study, and Ms. Jean Bedger, of the Chicago Council for Community Services, were very helpful, and I would like to thank them for their assistance.

Except for the methods developed by the Milwaukee Association of Commerce, which I used, all of the remaining work was developed basically by the author. Final responsibility for the content of this study rests with me.



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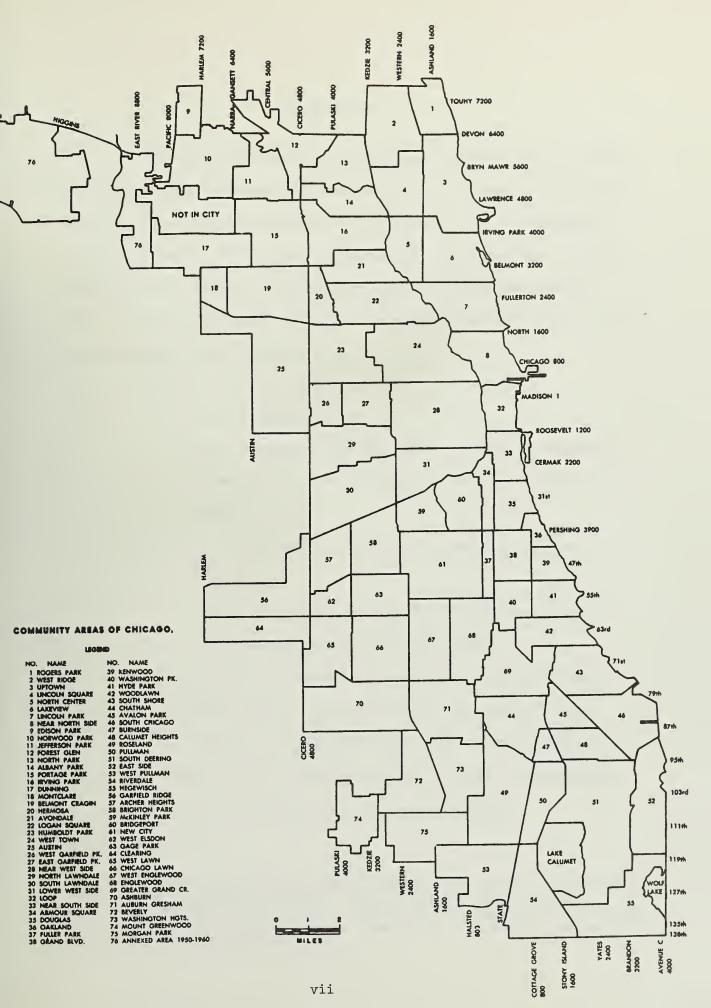
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I. INTRODUCTION

Population movements are significant in the study of economic changes, because population and economic changes interact. Under varying conditions population changes may influence or be influenced by economic changes. Furthermore, knowledge of future population characteristics can be used in developing economic policies and programs. Thus, a workable predictor of population shifts could be used as a tool in formulating "proper" policies.

The goals of this project are:

- 1) To predict and estimate:
 - a) total community area population for the 75 community areas of the city of Chicago for the years 1975 and 1980.
 - b) racial composition for the 75 areas for the year 1980, and
 - c) population composition by 16 age/sex groups for the 75 areas for the years 1975 and 1980;
- 2) To build the framework for extending the projections on an annual basis for the years 1976 through 1979; and
- 3) To develop a methodology and a model in making the estimates which may then be applied to other intercensal and postcensal periods, as well as other areas.

Although a 76th Community area has been annexed to the city, there is not a sufficient amount of data available at this time to justify an estimate for this area. Therefore, all mention to city totals, city averages, and the like in this paper will refer to the portion of Chicago excluding Community area 76.

In seeking to estimate future population trends, a pattern has to be discovered prevalant in the past. Future trends have to be based on past trends in the absence of a foolproof crystal ball. One must assume that certain past trends will continue into the future, and that nothing significant will occur to alter those trends. In this project, therefore, past trends will play a significant role in determining future trends.

Changes in population for a given area can occur as a result of only one of three different events; namely, i) births, ii) deaths, and iii) migratory movements. The rates of occurrence of each of these population changes can be measured. Births and deaths are recorded by various groups and agencies. Migration, however, is not. Obviously, it would be most beneficial to have separate figures on in-migration and out-migration. For an area the size of a country, such data would be available. For smaller areas in this country, such data is not available. A proxy variable for gross in-migration minus gross out-migration has to be used. Since total changes in population are measured every ten years, and they are equal to births minus deaths plus gross in-migration minus gross out-migration, the proxy variable, net migration, can be derived by subtracting births minus deaths from total changes in population.

The past levels of occurrence of each of the population changes could be simply extended into the future. Other factors, however, also tend to influence those rates besides the past rates themselves;

each is the result of many individual decisions as well as certain uncontrollable factors. Looking at past occurrences, however, general patterns can be detected. Certain characteristics of an area tend to contribute to population changes. To try to recognize those general patterns to find those certain characteristics, thus, becomes a major ingredient of an undertaking such as this.

In the following chapters, I will first present a very brief look at Chicago's historical growth patterns. Then I will detail the methods used in obtaining the estimates; thus outlining the model.

Finally, I will discuss the results obtained and present those results.

II. A BRIEF LOOK AT CHICAGO'S HISTORICAL GROWTH PATTERN

Chicago's growth rate over the past two centuries has been phenomenal. Chicago is the youngest of the world's large cities, ranking second in the nation and in the top fifteen in the world, in population size. The first permanent ssttlement was established only about 200 years ago. Fifty years later there were still only a few dwellings. By the turn of the century, however, several million people had moved into the area.

Chicago's central location and its good transportation connections, being able to link the agricultural and industrial areas of the nation, prompted this rapid growth as well as its own industrialization. Rapid growth in the area has continued through this century. Since about the 1930's, however, most of the growth has occurred outside of the city limits in the suburban areas. The entire metropolitan area currently consists of about eight million inhabitants; the city proper about 3.5 million.

Much of the earlier growth was due mainly to the arrival of European immigrants; thus, Chicago was and still remains a highly ethnic city with various ethnic groups dominating particular sections of the city. Recent patterns, however, show that many of the second and third-generation Chicagoans, mostly white, have been leaving the city proper, and moving to the suburban areas. At the same time, there has been a substantial increase in the black population of the city. Chicago remains a highly racially segregated city. Thus, much of the housing vacated by the people leaving the city, near predominantly black areas, has been occupied by the growing black population. It should be noted,

also, that a sizable Spanish-speaking community has recently developed in the city, and its rate of growth has been high, too.

In the immediate future the patterns of the recent past can be reasonably expected to continue.

III. METHODOLOGY

A. General Comments

Population forecasting is not an easy task. The selection of the kind of forecast to present, the methods used in deriving estimates, and the factors used in determining future trends are all subject to errors of omission, as well as of commission, even if one uses the most highly scientific methods in their determination. The estimates obtained can only serve as guides to the direction and magnitude of change, and even those may not be accurate. Available data is not always accurate, and much potentially useful data is unavailable. Van Beuren Stanbery summed up well the dismal prospects awaiting a population forecaster:

"By chance, a figure drawn at random or a curve sketched freehand on paper may come closer to the future population than one derived from the most painstaking study."

Fortunately, he continues with some encouragement, "But in the long run, projections based on thoughtful analysis should prove far more dependable than off-the-cuff 'guesstimates'."

In the field of population projection, "thoughtful analysis" requires analyzation of past trends and rates of change and the determination of the effect and extent of past factors upon future trends.

Better Population Forecasting for Areas and Communities, 1952, p. 1.

³ Ibid.

I will try to be consistent with this fundamental precept.

In making population projections, certain basic assumptions must be made. Unforeseen circumstances are always changing population patterns. A projection should be discarded, however, if one of the following assumptions is violated:

- The basic political, social, and economic framework and institutions of the country will remain unchanged during the study period.
- 2) A nation-wide or area-wide disaster of any kind will not occur during the study period. (This includes natural disasters, as well as man-made ones, such as wars.)
- 3) There will be no significant changes in any governmental regulations concerning population change patterns during the study period.

Given the previously stated assumption that past trends will continue into the future, the past trends have to be discovered first. Since the period of projection is the decade of the 1970's, the past trend period which I have chosen to use, consists of the two decades preceding the 1970's. To go back much further, I believe, would not be very useful. The characteristics of the immediately preceding time period may be justifiably assumed to be present in the next time period; The same is not true of previous periods. Therefore, in estimating past trends, I have made population changes occurring in the decade of the 1960's the dependent variable with various factors previous to that

time serving as independent variables. The results obtained will then be applied to the following decade. I will outline the specific methods used in the three separate phases (total Community Area population, racial composition, and age/sex composition) further in this chapter.

The following data will be used as input data:

1950, 1960, and 1970 population by Community Area and Race;

1950 - 1973 Birth and Death Statistics by Community Area;

1950, 1960, and 1970 population of females of child-bearing

age by Community Area (females, aged 15--44);

1950, 1960, and 1970 median income, male civilian labor force unemployment rate, and median school years attained by persons 25 years of age and older by Community Area;

1950, 1960, and 1970 population by age/sex groups by Community Area:

1950, 1960, and 1970 population by age/sex groups for the United States; and

1970 - 1980 Projected Population Estimates by age/sex groups for the United States as estimated by the Bureau of the Census.

All of the preceding data are available either through reports of the U. S. Census Bureau, in a series of Chicago Area Community Fact Books⁴, or are tabulated by the Chicago Board of Health or the State of Illinois Department of Public Health.

The data was selected by the author as having the greatest possible impact on population changes. This does not exclude the possibility of other important factors. As I have discussed before, population changes are the result of a countless number of variables; only those most apparently significant could have been chosen. Indeed, all of the variables chosen do affect population changes. Finding the most significant ones is a major task of this project.

Using the available data, other variables were created. A list of all variables used is contained in Appendix I. In the balance of the paper, I may refer to all of the variables by the names assigned to them in Appendix I.

Philip M. Hauser and Evelyn M. Kitagawa, Local Community Fact Book for Chicago, 1950, 1953.

Evelyn M. Kitagawa and Karl E. Taeuber, Local Community Fact Book, Chicago Metropolitan Area, 1960, 1963.

Chicago Association of Commerce and Industry, Research and Statistics Division, Community Area Data Book for the City of Chicago, 1973.

A prediction of future events based on past knowledge requires that the general characteristics of the past and future areas under study must be similar. In using the same area, this problem is solved. But, especially in an urban setting, characteristics of neighboring areas often tend to have an effect on the "home" area's population-change patterns also. Therefore, it would be useful to have each Community Area's "neighboring" Area's characteristics, so that their impact could be studied. Accordingly, for each data element of a particular Community Area which is available, I will derive a corresponding value for that Area's Neighboring Areas. A full discussion of the methodology used in obtaining these "neighboring" values is provided in Appendix II.

B. Prediction of Total Community Area Population for each of the 75 Community Areas for the Years 1975 and 1980.

For the years 1975 and 1980 for each Community Area, the population in the year desired is equal to the population in 1970, plus the number of births, minus the number of deaths, and plus the number of net migrants in the interim.

Since 1970 population figures are available, what needs to be obtained are estimates of 1970-1975 and 1975-1980 birth, fertility, death, and net migration rates from which numbers of births, deaths, and net migrants could be derived.⁵

Fertility rates and birth rates are alternative measures of birth patterns. I will obtain alternative results using each of these measures for 1980.

As I have outlined previously, birth, fertility, death, and migration rates are dependent not only on their own past rates but on other factors also. To find these factors, I will use

((BR
$$_{\rm W2}$$
) - (C-BR $_{\rm 2}$)),((FR $_{\rm W2}$) - (C-FR $_{\rm 2}$), and ((MR $_{\rm W2}$) - (C-MR $_{\rm 2}$)),

the differences between a Community Area's Birth, fertility, and net migration rates and the entire City's corresponding rates as the dependent variables. Serving as the independent variables will be the ones in the variable list occurring before 1960, found to have the greatest effect. As I discussed previously, the attempt to find those characteristics having the greatest effect on population changes is a major task of the project.

As the fourth dependent variable, I will use (DR_{w2}). Based on past observations, death rates in particular areas tend to remain somewhat constant over time in spite of changes in the overall City death rate. Thus, I will not use differences from the City average in the case of deaths. The independent variables will be searched for, as in the other cases.

Having found the most satisfying regression equations 6 for this time period, I will use the obtained parameters and corresponding independent variables of ten years later, to obtain estimates for BR $_{\rm w3}$, FR $_{\rm w3}$, MR $_{\rm w3}$, and DR $_{\rm w3}$. Estimates of C-BR $_{\rm 3}$, C-FR $_{\rm 3}$, and C-MR $_{\rm 3}$ will be calculated as follows:

$$C-XR_3 = C-XR_2 + ((C-XR_2) \cdot ((C-XR_2 - C-XR_1)/(C-XR_1))), \text{ for } X = (B,F,M).$$

This equation reduces to:

$$C-XR_3 = (C-XR_2)^2/(C-XR_1)$$
.

The availability of birth and death statistics for the years 1970 - 1973 eliminates the need to estimate values for those years.

Having thus obtained estimates for ${\rm BR}_{\rm w3},~{\rm FR}_{\rm w3},~{\rm MR}_{\rm w3},$ and ${\rm DR}_{\rm w3},$ the estimated population of community area w in the year 1975 is equal to:

In these and other equations, the coefficients were estimated by the method of Ordinary Least Squares (Bimed 34S, modified by H. Stokes, University of Illinois at Chicago Circle Computer Center). This method was chosen because it provides the best linear unbiased estimators for a reduced-form single equation, which each of the equations were.

POP_{w3}(z = total) + B(v = 1970 + 1971 + 1972 + 1973)w
- D(v = 1970 + 1971 + 1972 + 1973)w
+ (0.1)
$$\cdot$$
 ((BR_{w3}) \cdot (POP_{w3}(z = total))
- (DR_{w3}) \cdot (POP_{w3}(z = total)))
+ (0.5) \cdot ((MR_{w3}) \cdot (POP_{w3}(z = total))),

using birth rate estimates.

The estimated population of community area w in the year 1980 is equal to:

POP_{w3}(z = total) + B(v = 1970 + 1971 + 1972 + 1973)w
- D(v = 1970 + 1971 + 1972 + 1973)w
+ (0.6)
$$\cdot$$
 ((BR_{w3}) \cdot (POP_{w3}(z = total))
- (DR_{w3}) \cdot (POP_{w3}(z = total)))
+ ((MR_{w3}) \cdot (POP_{w3}(z = total))),

using birth rate estimates, and:

$$POP_{w3}(z = total) + B(v = 1970 + 1971 + 1972 + 1973)w$$

$$- D(v = 1970 + 1971 + 1972 + 1973)w$$

using fertility rate estimates.

C. Prediction of Racial Composition for Each of the 75 Community Areas for the year 1980

A glance at the patterns of racial composition of the City of Chicago during the past few decades indicates a dominant pattern:

- 1) predominantly non-white areas remain so; 2) white areas which are in close proximity to black areas in many parts of the city, tend to become predominantly non-white over time with a few exceptions; and
- 3) white areas not in close proximity to non-white areas remain predominantly white; that is, no "pockets" of predominantly non-white population springup in a previously all-white area.

In this section, I will include all "other" races as stated under the category "non-white" along with the Black Race. The relative smallness of the "other" category as well as the lack of a generally recognizable pattern for it, justifies this.

The single exception to this rule occurred in the Southwest Side Community of Garfield Ridge, when the Chicago Housing Authority completed the LeClaire Courts housing project which was subsequently settled almost entirely by non-whites. The LeClaire Courts Project, however, lies in a remote section of the Garfield Ridge Community, it must be noted.

As has been noted, Chicago remains a highly segregated city. Various open-housing ordinances and equal opportunity laws have not altered the aforementioned patterns. Under the assumption that no new laws will be enacted, one can only assume that these patterns will continue into the future.

Besides past patterns of racial composition, certain economic variables may also influence future patterns. They should also be tested.

For the 75 observations (the 75 Community Areas), an equation can be estimated using PARW as the dependent variable, and searching for the most significant independent variables, as before.

The parameters of this equation, when solved, can be used in the determination of 1980 estimates of percent of Community Area population, that is of the white race, by using the values of the corresponding independent variables of 10 years later. PARW_{w4} would provide estimates of racial composition (percent white, and, therefore, percent non-white), for each of the 75 Community Areas for 1980.

D. Prediction of Population by Age/Sex Groups for the 75 Community Areas for 1975 and 1980

In searching for a good method to perform this prediction, I came across a method devised by the Business Research Division, Milwaukee

Association of Commerce⁹. To quote a report issued by the Association:
"It is a 'leach' method which utilizes the relationship of Milwaukee's and the nation's age group population data when expressed as percentages of totals."

10

This method assumes that the relationship of a small area's percentage of total to the entire country's percentage of total in each particular age/sex group (where ages are broken down into 10-year groups), will be the same for the next highest 10-year group, ten years hence. The values of the age group 0--9 are the residual which is left.

The accuracy of this method depends on the accuracy of the United States Census Bureau's projections. They made three separate projections, based on three separate fertility assumptions, and I will also make three separate projections, based on the three different fertility assumptions.

In estimating 1980 age/sex group percentages, I will also use 1960 and 1970 estimates obtained in the same method, and compare the estimates to the actual values to find any consistent errors. The error term will then be added to get the final results.

See Elam E. McElroy, 1970 Population Projections, Milwaukee and Surrounding Counties, 1961.

¹⁰ Ibid., p. 33.

The error term for each Community Area and each age/sex group is:

$$\frac{1}{2} (((POPX_{abw3} - ((POP_{w3(z = total)}) \cdot ((U.S.)POPX_{ab3}/(U.S.)POP_3) \cdot ((POP_{ab*w2}))/POPX_{abw3}) + (((POPX_{abw2} - ((POP_{w2(z = total)}) \cdot ((U.S.)POPX_{ab2}/(U.S.)POP_2) \cdot (RPOP_{ab*w1}))/POPX_{abw2})))$$

(* the values of b*, above and below, refer to the decennial age group preceding the group represented by b).

The estimated population of each age/sex group in each Community Area using the error correction in 1980 is:

$$POPX_{abw4} = (POP_{w4(z = total)} \cdot POPEST_{ab} \cdot RPOP_{ab*w3}) + error term,$$

where $POP_{W4}(z = total)$ has been estimated as outlined in Section B of this chapter.

The estimated population of each age/sex group in each community area in 1975 will be obtained by averaging the projected 1980 percent-of-total population for each age/sex group in each community area and the actual 1970 percent-of-total (for each group in each community area) and multiplying by the population in 1975 as estimated.

IV. FACTORS AFFECTING POPULATION CHANGES

A. General Observations

The results of the five estimated equations as outlined in Chapter III are presented in Appendix III. In each case, two equations are given: equation (a) containing a constant term, and equation (b) being forced through the origin. As one would expect, the constant terms, in each case, proved to be not significantly different from 0. Thus, the coefficients obtained in each of the (b) equations were used in estimating future trends.

Upon inspection of the equations, it can be seen that: a) the dependent variables are, in each case, significantly dependent upon their own past rates; b) the dependent variables are, in each case, also significantly dependent upon at least one other past population change pattern, thus implying that the three possible types of changes in population are also influenced by each other, or influenced by the same things; and c) not all of the dependent variables are significantly affected by economic factors, or, at least, the economic factors which I tested: income, employment, and educational levels. A more detailed inspection will follow in subsequent sections of this chapter.

B. Births and Fertility

It is not surprising that it was discovered that birth rates and fertility rates are influenced most by the same factors. Each is positively related to its own past rate. Past net migration rates are negatively related to birth and fertility rates. This can probably be

attributed to the fact that areas which have had a high net migration rate (a gross in-migration rate much higher than gross out-migration) have tended to receive people who are less likely to have children. Child-bearing is usually found to be greater among steady populations than among mobile populations.

Income changes are found to be negatively related to birth and fertility rates, reaffirming the classical observation that lower-income persons tend to have more children than higher-income persons. Educational levels act in the same manner with less educated persons having more children, generally, than the more educated; accordingly, changes in educational levels of a community are negatively related to birth and fertility rates.

It was also found that the variable N-W-%CH was negatively related to birth and fertility rates; that is, the more an area's neighboring areas became non-white, the greater was that area's birth and fertility rates in the succeeding period. This is so because of the recent Chicago pattern which I have discussed, of expansion of the predominantly black community into previously all-white areas. This expansion is foreshadowed, often, by expansion into a neighboring area in the previous period. It must be noted that birth and fertility rates are significantly higher among non-whites than among whites. Thus, the more an area's neighboring areas become non-white, the greater the chance of the non-white population in that area increasing in the succeeding period with its accompanying increase in birth and fertility rates.

The apparent discrepancy with areas of higher unemployment being positively related to fertility rates and negatively associated with birth rates, can be explained because areas of higher unemployment tend to have less females of child-bearing age per population than areas of lower unemployment. Areas of lower unemployment tend to have a more family-centered populace along with more children and higher birth rates.

The birth equation was much more satisfactory than the fertility equation. Thus, the results obtained using it were the ones used in further work as actual estimates of future birth statistics.

C. Deaths

Since man has little control over death, its rate was not difficult to estimate. As can be seen, death rates are positively related to past death rates, as expected. They are also inversely related to birth rates, implying that areas of higher birth rates have lower death rates, and inversely; this can best be explained because areas with younger populations have the former and areas with older populations have the latter as a general rule. None of the economic variables were found to be significantly related to death rates. This is probably because there is not enough of a difference among the community areas in economic factors to influence something which is so consistent over large areas.

, 3.

D. Migration

The other components of population changes are counted and recorded; migration is not. It is the most difficult to estimate, and the key to the total population-change figures. In estimating an equation to explain migration rates, 10 separate variables were found to be significant enough to affect migration rates.

Migration rates were found to be positively related to past migration rates and negatively related to past fertility rates. That migration rates are negatively related to past fertility rates is probably due to the fact that areas having high fertility rates (a high level of production of children) became more densely populated, causing gross out-migration to become greater than gross in-migration, in an attempt to alleviate the situation. Thus, net migration rates would fall. More simply, families with increasing numbers of children would move out of the area in search of larger places of residence, generally not available in the same area because the housing stock is somewhat similar in each area.

Three of the factors representing changes in racial patterns proved to be significantly related to migration patterns, as could be expected. The results show that net migration is greater in areas which are more predominantly white, and lesser in areas which are more predominantly non-white; as neighboring areas become more non-white, net migration in a given area falls. These patterns reaffirm the observation of whites moving away from non-whites, moving into their areas, or into neighboring areas.

The relationship between unemployment and migration shows a pattern of movement from areas of low unemployment into areas of high unemployment. This is because migration is generally more prevalent among those with better jobs. Thus, in areas of high unemployment, gross out-migration tends to be low, and, therefore, net migration high. In areas of low unemployment, the opposite is true.

Migration is also found to be greater among the more educated.

This could also be expected since the more educated tend to be more mobile than other segments of the population.

E. Racial Composition

Patterns of racial composition, although often influenced by economic conditions, were found to be dominantly influenced by past patterns and changes in racial composition; none of the economic variables tested were found to be significant.

The more an area consisted of a particular racial group in the past, the more likely it was to remain so. In fact, it was found that this was particularly true in areas which contained an overwhelming proportion of whites. Accordingly, I included a dummy variable (D1) in the equation having the value 1 for all areas in which 90 percent or more of the population was white. It may, perhaps, help to explain the immeasurable factor of neighborhood solidarity. A similar variable was tested for the non-white population, but it was not significant. As expected, PARW and D1 were both positively related to the dependent variable.

It may seem unusual that death rates are significantly positively related to racial composition. High death rates, however, may serve as a proxy for a generally older population. Currently, the non-white population in Chicago is much younger than the white population on the average. Thus, a higher death rate may signify an older population which is more likely to be white than non-white.

As I have discussed previously, it has been the recent pattern in Chicago, that the non-white population has been expanding, both numerically and geographically. As this expansion occurs in neighboring areas, it is more likely to occur in the home area in succeeding periods. In an attempt to measure this phenomenon, I created another dummy variable (D2), having the value 1 for all areas in which the percent of neighboring area population, which is white, declined by more than 10 percent. This may, perhaps, explain the observed pattern. As expected, this variable was negatively related to the dependent variable.

V. THE ACTUAL POPULATION ESTIMATES

The results of the estimates made by the methods outlined in Chapter III are presented in Appendix IV. Although the numbers speak for themselves, I will attempt to provide some useful comments and clarifications in this chapter.

before accepting any of the figures derived, one must remember that the figures are estimates. A figure which turns out to be five percent or less away from the actual values would be a very good estimate. But many of the figures will be more inaccurate than that; some are bound to be terribly inaccurate. Some of the errors can be attributed to mere chance; most of the errors to unpredictable occurrences and the existence of a free society, one in which population-change decisions are, for the most part, free to be made by individuals.

Tables A and B contain projected 1980 population figures using birth and fertility rate projections, respectively, to predict births. The components of change are also presented.

Table C contains estimated 1975 and 1980 population figures obtained using birth rate projections to predict births.

Table D contains the projected racial composition of the estimated 1980 population. In making the estimates, some of the estimated values of percent white turned out to be negative. Since this is an impossibility, the values thus estimated were approximated to one percent. In this table, especially, the estimated individual percentages can not be accepted as very accurate. What they do represent is a likelihood of racial change patterns. Certain low values for percent

white in 1980 will not materialize; "neighborhood solidarity" does exist in the City of Chicago and, barring unforeseen circumstances, will continue to exist. It can not be measured accurately and therein lies the problem. Because of the approximate values used and the immeasurability of certain factors, I believe that the estimates for percent white are somewhat biased downward.

Tables E, F, and G are identical except for the assumptions on which they are based. As I noted previously, the Census Bureau made predictions of United States population by age/sex groups for 1980 using three separate fertility assumptions. In estimating community area population by age/sex groups, I used each of these three assumptions in obtaining estimates. Thus, each of the tables corresponds to one of the three assumptions. Table E corresponds to the Census Bureau's assumption of 2.45 as the average number of births per woman upon completion of child-bearing (Series D); Table F, 2.11 (Series E); and Table G, 1.80 (Series F). Each of the tables presents a prediction of population by 16 age/sex groups for the years 1975 and 1980.

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APPENDIX I

Definition of Variables

The subscripts used below take on the following values:

a = male, female

b = ages 0 - 9, 10 - 19, 20 - 29, 30 - 39, 40 - 49, 50 - 59, 60 - 69, over 70

v = 1970, 1971, 1972, 1973

w = community areas No. 1 through No. 75

x = (1 = 1950 to 1960), (2 = 1960 to 1970), (3 = 1970 to 1980)

y = (1 = 1950), (2 = 1960), (3 = 1970), (4 = 1980)

z = white, black, other, total nonwhite, total

Where applicable, the prefix "C-" preceeding the following variables represents the total Chicago value of that element, in lieu of the subscript "w", representing the value for the particular Community Area.

Also, where applicable, the prefix "N-" preceeding the following variables represents the value of that element, for a given Community Area's "neighboring" Community Areas. For a full discussion of the methodology used in obtaining these "neighboring" values, see Appendix II.

POPwyz is the number of persons of a given race residing in the given Community Area in the given year.

B_{wx} is the number of live births by residence of mother, by Community Area occurring in the given time period.

 $D_{
m WX}$ is the number of deaths by residence of the deceased, by Community Area occurring in the given time period.

 $\frac{\mathrm{is}}{\mathrm{vw}}$ is the number of live births by residence of mother, by Community Area occurring in the given year.

 ${
m D}_{
m VW}$ ${
m \underline{is}}$ the number of deaths by residence of the deceased, by Community Area occurring in the given year.

FCBA $\underline{\text{is}}$ the number of females, aged 15 -44, residing in the given Community Area in the given year.

 $\frac{\text{is}}{\text{wy}}$ the median income of all individuals in a given Community Area in the year preceding the stated census year.

UNEM is the percent of the male civilian labor force unemployed in the given Community Area in the given year.

M-SCH_{wy} is the median number of school years attained by persons 25 years of age and older in a given Community Area at the given year.

 $\frac{\mathrm{is}}{\mathrm{abwy}}$ $\frac{\mathrm{is}}{\mathrm{min}}$ the number of persons of the given sex and age group residing in the given Community Area in the given year.

POPEST_{ab} is the percent of the total United States population in 1980 estimated by the United States Bureau of the Census, to be in the given sex and age group.

 $\underline{\text{is}}$ the change in the number of persons of a given race, residing in a given Community Area during the given time period.

 M_{WX}

is the number of net migrants to enter a given Community

Area during the given time period.

$$(M_{wx} = POPCH_{wx}(z = total) - B_{wx} + D_{wx})$$

BRwx

is the number of live births by residence of mother, by Community Area, occurring in the given time period per population size at the beginning of the period. This is called the Birth Rate.

$$(BR_{wx} = B_{wx} / POP_{wy(z = total)})$$

DRwx

is the number of deaths by residence of the deceased, by Community Area, occurring in the given time periods per population size at the beginning of the period. This is called the Death Rate.

$$(DR_{wx} = D_{wx} - POP_{wy}(z = total))$$

MR_{wx}

is the number of net migrants to enter a given Community Area during the given time periods, per population size at the beginning of the period. This is called the Migration Rate.

$$(MR_{WX} = M_{WX} / POP_{Wy(z = total)})$$

FRwx

is the number of live births by residence of mother, by

Community Area, occurring in the given time period, per

number of females of childbearing age at the beginning of

the period. This is called the Fertility Rate.

$$(FR_{wx} = B_{wx} / FCBA_{wy})$$

 $\mathrm{CH}_{\mathtt{WXZ}}$

is the change in the number of persons of a given race residing in a given Community Area during the given time periods, per the number of persons of that race, residing in t given Community Area, at the beginning of the period. This is called the Percent Change in Population for a given Community Area, Race, and time period.

$$(CH_{WXZ} = POPCH_{WXZ} / POP_{WYZ})$$

 ${\rm PARW}_{\rm wy}$

is the percent of total Community Area population for a given Community Area, that is of the white race at the given time period.

$$(PARW_{wy} = POP_{wy}(z = white)/POP_{wy}(z = total))$$

W-%CH_{WX}

is the percent change in the percent of total Community Area population for a given Community Area, that is of the white race during the given time period.

$$(W-\%CH_{WX} = (PARW_{W(y+1)} - PARW_{Wy})/PARW_{Wy})$$

Y-%CH_{WX}

is the percent change in median income of all individuals in a given Community Area during the given time period.

$$(Y-\%CH_{wx} = (INC_{w(y+1)} - INC_{wy})/INC_{wy})$$

Uwy

is the percent of the male civilian labor force unemployed in the given Community Area in the given year, divided by

the city-wide unemployment rate for that year. This is called the Relative Unemployment Rate, or, for the sake of simplicity, the Unemployment Rate.

$$(U_{WV} = UNEM_{WV}/C-UNEM_{V})$$

SCHwy

is the median number of school years attained by persons 25 years of age and older in a given Community Area at the given year, divided by the city-wide median-schooling rate for that year. This is called the Relative Schooling Attained Rate, or, for the sake of simplicity, the Schooling Rate.

$$(SCH_{WV} = M-SCH_{WV} / C-M-SCH_{V})$$

U-%CH_{wx}

is the percent change in the Relative Unemployment Rate in a given Community Area during the given time period.

$$(U-\%CH_{wx} = (U_{w(y+1)} - U_{wy}) / U_{wy})$$

S-%CH_{WX}

is the percent change in the Relative School Attained Rate in a given Community Area during the given time period.

$$(S-\%CH_{wx} = (SCH_{w(y+1)} - SCH_{wy}) / SCH_{wy})$$

- $(U.S.)POP_y$ is the total number of persons in the entire United States in the given year.
- $(U.S.)POP_{aby}$ is the number of persons of the given sex and age group, residing in the entire United States in the given year.
- RPOP abwy is the ratio of a Community Area's percentage of total population in a given sex and age group, to the entire country's percentage of total population in a given sex and age group, for a given Community Area in a given year.

$$(\text{RPOP}_{\text{abwy}} = \frac{\text{POPX}_{\text{abwy}}}{\text{POP}_{\text{wy}}(\text{z = total})} \int \frac{(\text{U.S.})\text{POPX}_{\text{aby}}}{(\text{U.S.})\text{POP}_{\text{y}}})$$

- \underline{is} a dummy variable, assigned the value 1 for all Community Areas whose percentage of population which is white is greater than 90 percent. (PARW > 0.90)
- ${
 m is}$ a dummy variable, assigned the value 1 for all Community Areas whose Neighboring Area's percent of population which is white has decreased by more than 10 percent during that decade. (N-W-%CH < -0.10).

APPENDIX II

Methodology Used in Obtaining Neighboring Area Statistics

For Each Community Area

For each Community Area given the following variables as defined in Appendix I: POP_{wyz} , B_{wx} , D_{wx} , B_{vwz} , D_{vwx} , $FCBA_{wy}$, INC_{wy} , $UNEM_{wy}$, $M-SCH_{wy}$, $POPCH_{wxz}$, M_{wx} , BR_{wx} , DR_{wx} , MR_{wx} , FR_{wx} , CH_{wxz} , $PARW_{wy}$, $W-%CH_{wx}$, $Y-%CH_{wx}$, U_{wy} , SCH_{wy} , $U-%CH_{wx}$, and $S-%CH_{wx}$, new variables were created corresponding to the available variables bearing the prefix "N-", and representing the value of each Community Area's Neighboring Areas.

For each Area, this was done by selecting the four areas most nearly directly north, south, east, and west, of the given Area, and averaging the values of each variable in those four areas. The newly created variables represented the "neighboring" values for each variable for each Community Area.

Without even glancing at a map at which point it becomes obviously clear, one can realize that all of the areas bordering on the lakefront and on the suburbs have a direction or two missing. To alleviate this problem for the purpose of calculation, seven mythical areas were created to serve as proxies for the missing directions. These seven areas represented: The North Lakefront, The South Lakefront, the Far South Lakefront and Indiana Border, the Southwest Suburbs, the Western Suburbs, the Northwest Suburbs, and the Northern Suburbs. Values for these mythical areas were then obtained by averaging, for each

variable, the value of all of the Community Areas bordering on the Mythical Areas. This can be justified because all of the areas bordering the same Mythical Area of Chicago which has been created, actually do border an Actual Area corresponding to the Mythical Area for which data is unavailable. The effects of bordering this same area would indluence that area or else similar effects would be obtained by bordering this same area.

APPENDIX III

Equations

The following regression equations were the most satisfactory ones found in obtaining explanations for past trends in population-change patterns:

 $\bar{R}^2 = 0.65093$

SE = 0.03513

N = 75 C. A.'s

(Note: The numbers in parentheses are the standard errors of the coefficients.)

$$((BR_{w2}) - (C-BR_2)) = 0.45960 BR_{w1} - 0.09070 MR_{w1} - 0.1010 N-W-%CH_{w1}$$
 (1b)
 (0.06105) (0.01339) (0.02744)
 $- 0.10440 Y-%CH_{w1} - 0.01720 U_{w2} - 0.12760 SCH_{w2}$
 (0.05760) (0.00909) (0.01241)

$$((FR_{w2}) - (C-FR_{2})) = 0.000167 + 0.2968 FR_{w1} - 0.2261 MR_{w1}$$
 (2a)
$$(0.2684) (0.1062) (0.09101)$$

$$- 0.2287 N-W-$CH_{w1} - 0.4744 Y-$CH_{w1}$$
 (0.1476)
$$(0.3263)$$

$$+ 0.06804 U_{w2} - 0.5018 SCH_{w2}$$
 (0.04979)
$$(0.2146)$$

$$\overline{R}^{2} = 0.51505$$

$$SE = 0.18759$$

$$N = 75 C. A.'s$$

$$((FR_{w2}) - (C-FR_{2})) = 0.2969 FR_{w1} - 0.2261 MR_{w1} - 0.2287 N-W-$CH_{w1}$$
 (2b)
$$(0.0916) (0.07468) (0.1465)$$

$$- 0.4743 Y-$CH_{w1} + 0.06805 U_{w2} - 0.5016 SCH_{w2}$$
 (0.3057)
$$(0.04787) (0.07769)$$

$$(DR_{w2}) = 0.013980 - 0.15090 BR_{w1} + 1.277 DR_{w1}$$
 (3a)
$$(0.008499) (0.01872) (0.05766)$$

$$\overline{R}^{2} = 0.88685$$

$$SE = 0.01732$$

$$N = 75 C. A.'s$$

$$(DR_{w2}) = -0.13260 BR_{w1} + 1.352 DR_{w1}$$
 (3b)
$$(0.01523) (0.03532)$$

```
((MR_{w2}) - (C-MR_2)) = -0.4820 + 0.4160 PARW_{w2} - 0.1796 FR_{w1}
                                                                                     (4a)
                           (0.2951) (0.1104) (0.08638)
                       + 0.14520 MR<sub>wl</sub> - 0.3748 N-PARW<sub>w2</sub>
                        (0.1309) (0.04617)
                       + 0.2664 \text{ N-W-}\%\text{CH}_{\text{W1}} (0.1309)
                       + 0.18010 U<sub>w2</sub>
                                               (0.04617
                       + 0.6701 \text{ SCH}_{W2} - 0.16040 \text{ N-U}_{W2}
                        (0.1421) (0.08552)
                       + 0.3354 \text{ N-U-\%CH}_{w1} + 1.9000 \text{ N-SCH-\%CH}_{w1}
                         (0.1339) (0.5403)
\frac{2}{R} = 0.64260
SE = 0.11558
N = 75 \text{ C.A.'s}
((MR_{w2}) - (C-MR_2)) = 0.3682 \text{ PARW}_{w2} - 0.23660 \text{ FR}_{w1} + 0.1938 \text{ MR}_{w1}  (4b)
                         (0.1087) (0.08130) (0.06519)
                       - 0.5207 N-PARW<sub>w2</sub> + 0.3579 N-W-\%CH<sub>w1</sub>
                                                (0.1219)
                          (0.1604)
                       + 0.16780 \, \text{U}_{\text{W2}} + 0.48760 \, \text{SCH}_{\text{W2}} - 0.2243 \, \text{N-U}_{\text{W2}}
                          (0.04636) (0.09812) (0.07686
                       + 0.3562 N-U-%CH<sub>wl</sub> + 1.7220 N-SCH-%CH<sub>wl</sub>
                          (0.1355)
                                                 (0.5390)
```

$$(PARW_{w3}) = 0.03952 + 0.5212 PARW_{w2} + 1.209 DR_{w1}$$

$$(0.08470) (0.1027) (0.5753)$$

$$+ 0.3301 Dl - 0.1593 D2$$

$$(0.07962) (0.04576$$

$$\frac{2}{R} = 0.82655$$

$$SE = 0.16102$$

$$N = 75 C.A.'s$$

$$(PARW_{w3}) = 0.5091 PARW_{w2} + 1.012 DR_{w1} + 0.3246 Dl - 0.1654 D2 (5b)$$

$$(0.09881) (0.3887) (0.07829) (0.04362)$$

APPENDIX IV

- The following tables are presented in this Appendix:
- Table A. Projected 1980 Population (using birth rate projection to predict births) along with the components of change in population, 1970-1980, for each of the 75 Community Areas of the City of Chicago.
- Table B. Projected 1980 Population (using fertility rate projection to predict births), along with the components of change in population, 1970-1980, for each of the 75 Community Areas of the City of Chicago.
- Table C. Projected 1975 and 1980 Population for each of the 75

 Community Areas of the City of Chicago.
- Table D. Projected Racial Composition in 1980 of each of the 75

 Community Areas of the City of Chicago.
- Table E. Projected 1975 and 1980 Population by 16 age/sex groups for each of the 75 Community Areas of the City of Chicago using the U.S. Census Bureau's Fertility Assumption Series D.
- Table F. Projected 1975 and 1980 Population by 16 age/sex groups for each of the 75 Community Areas of the City of Chicago using the U.S. Census Bureau's Fertility Assumption Series E.
- Table G. Projected 1975 and 1980 Population by 16 age/sex groups for each of the 75 Community Areas of the City of Chicago using the U.S. Census Bureau's Fertility Assumption Series F.

TABLE A. PROJECTED 1982 POPULATION

	C . A .	1970	BTRTHS	TOTATHS	JECTEDE1	CURES	<u>*****</u> *
		POPULATION			MIGRATION	CHANGE	POPULATION
	1 2	60781 65463	7715 6305	8193 8124	9531 9058	9063 7239	69844 72702
	3	136436	21887	25129	5731	2489	138925
	4 5	47829 39443	6601 6241	65 7 1 5328	1127 -1909	1156 -995	48985 38448
	6	114864	16623	16444	12925	13104	127968
	7 8	67635 75416	10906 9981	8263 94 27	936 -16452	3579 -15898	71214 54508
	9	13169	1171	1286	1679	1564	14733
	10 11	41912 27553	3703 3228	4588 3 314	4274 1809	3389 1722	45301 29275
	12	20531 16782	1601 1732	2246	1477 914	831 631	21362 17413
	14	47092	6568	6283	-1488	-1202	45890
	15 16	63608 54897	7745 8087	8334 6892	2289 -8012	1700 -6817	65308 48080
	17	43868	4473	4574	4255	4154	48022
	18 19	11730 57342	1401 7777	1450 7176	723 1455	674 2056	12404 59398
	20	19871	3013	2534	-2044	-1565	18306
	21 22	35771 88395	5730 15693	4540 11387	-2284 -5950	-1123 -1344	34648 87051
	23	71539	15339 28083	8541 15004	-8017	-1209	70336 112604
	24 25	1 2510 4 1 2799 4	22708	16976	- 25579 -5305	-12500 427	128421
	26 27	48420 51918	13905 16415	4565 4929	-25085 -29077	-15745 -17591	32675 34327
	28	78875	18696	11154	-47026	-39479	39396
	29 30	94891 62848	26478 12735	8024 8290	-52724 -12053	-34271 -7608	60 62 0 55 24 0
	31	44505	10280	5486	-8703	-3910	40595
	32 33	4858 8752	143 1837	2485 1458	455 - 3075	-1887 -2696	2971 6956
	34 35	13060 43705	2403 7803	1604 5179	-4595 -12865	-3795 -10241	9265 33464
	36	18291	3960	2164	-399	1397	19688
	37 38	7397 80125	1644 16138	839 14549	-2814 -12640	-2009 -11051	5388 69074
	39	26897	5127	3483	-6145	-4501	22396
	4 0 4 1	46024 33563	9379 4525	7761 3371	-11012 3199	-9394 4353	36630 37916
	42	53848	12834	6324	-20220	-13710	40138
	43 44	80 259 4 732 5	15413 9269	12111 4803	-18939 -9607	-15637 -5141	64622 42184
	45 46	14386 45655	2370 9644	1618 5832	-2319 -5992	-1467 -2170	12919 43485
	47	3181	630	399	-60	171	3352
	4.8 4.9	20123 62697	2749 10451	2068 7806	-3418 -1304	-2737 1340	17386 64037
	50	10915	1489	1311	-2154	-1976	8939
	51 52	19271 24649	30 66 32 96	1837 2503	533 -3166	1763 -2373	21034 22276
	53 54	40/30 7 150 18	5246	4079	-5113 -5429	-3946 -3755	36361 11263
	55	11345	2615 1654	941 1082	-2955	-2383	8962
	56 57	43012 11143	4493 1354	2931 1249	2580 - 545	4142	47154 10703
	58	35592	5734	4174	-3156	-1596	33996
	59 60	15701 35231	2352 6155	1935 4589	-2444 -5682	-2027 -4116	13674 31115
	61 62	60728 14059	11230 1416	7518 1272	-8780 1673	-5068 1818	5566¢ 15877
	63	26698	3064	3465	-1888	-2288	24410
	64 65	24560 18293	2707 2271	1857 1979	1181 1110	2021	2658 1 19695
	66	48511	5504	6603	5145	4346	52557
	67 68	61920 89595	12176 22147	7942 9062	-8990 -44054	-4757 -30969	57163 58626
	69 70	54414	12025	6065	-23045	-17090	37324 61477
	71	47154 68846	3436 12002	3368 8860	14255 -10582	14323 -7380	61466
	72 73	26757 36540	2231 5631	2771 4025	3006 312	2465 1318	29223 37858
	74	23139	1635	2704	2521	1452	24641
T	75 OTAL	31(43 3356109	3430 576862	3452 418135	792 -400024	77:) -241297	31 91 3 31 14 81 2
	_						

TABLE B. PROJECTED 1930 POPULATION USING FEPTILITY RATE PROJECTION TO PREDICT BIRTHS

C . A .	1970 PUPULATION	********* 618795	-DFATHS	JECTED EL	TOTAL CHANGE	20PUL ATION
12345678901200000000000000000000000000000000000	6743693446569114553894466709316654369316935651375119788939356513751437159446567093356651375751189356734393557512893565137573155769653366565437365754366665436666543666665436666666666	85731805550317724344229919331518662255550318762473180653119933115189653119933115189653119933115189653119933115189653119933115832946115933767831876778318767831199331151896783119933115189811338558119933115189811385211993311518981138558119311993311518981138558119311993311518981138558119933115189811385581199331151898113855811898993311852211993311518989933118522119933115189993311852211993311518999331189933115189993311899933118999331189993311899933118999331189993311899933118999331189993311899933118999331189993311899933118999331189993311899999999	812718 81	90736294974892535444079557043335555594072290979208433639505544880795570433355554448833639505644203811149554544883111495545488111495545488111495545481114955454811149554548111495545481114955454811149554545481114954528012124811312335592443113123355924431131233559244311314954528012124811312335592443113149545280121248113123355924431131495452801212481131249545280121248113124954528012124811314954528012124811314954528012124811314954528012124811314954528012124811314954452801212481131495445280121248113149544528012124811314954452801212481131495445280121248113149544528012124811314954452801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149544552801212481149545456442013811495445528012124811495445528012124811495445528012124811495445528012124814814814814814814814814814814814814814	94428791929528958958958958958958958958958958958958958	7021541 429541 429541 42961 4385641 130285651 145511 4551789 14551789 14551789 14551789 14551789 14551789 14551789 14551789 14551789 14651789 14651789 14651789 14651789 14651789 14651789 14663789 14663 14663 16763 16

TABLE C. PROJECTED POPULATION, 1975 AND 1980

•	PROJUC	TEU PUPULAT	1004 1975
	C • A •	1975	1980
	C. 123456789001234567890012345678900123456789001234567890012345678900123456788900123456789000000000000000000000000000000000000	19	1980 698447 1986 697725 1388488 12725 138849214 1453275 1453075 1453075 1453075 145308 145

TABLE D. PROJECTED POPULATION. IN 1990. BY RACIAL COMPOSITION

TABLE	D. PROJEC	TOU POP	OLATION,	TA TABLE DA	RACIAL	UMPUSII	LON	
C • A •	1970 TOTAL	1973 %-W	1970 WHITE	1970 NONWHITE	1980 TOT 4L	1980 %-W	1980 WHITE	1980 NONWHITE
1234567890112341567890112341567890122								
24567 89 0 1 2 3 3 5 5 6 5 6 5 6 6 6 6 6 6 6 6 6 6 6 6	125104 127994 48420 51918 79875 94891 62848 44535 4858 8752 13060 43795	94.0 67.0 2.8 1.9 26.2 3.2 89.2 96.4 84.5 11.8	117624 85815 1333 999 20647 3072 56075 42903 4103 1029 5600 5132	7480 42179 47087 50919 58228 91819 5773 1602 755 7723 7460 33573	112604 128421 32675 34327 39396 60620 55240 46596 2971 6056 9265 33464	58.6 14.9 1.0* 1.0* 1.0* 25.5 60.3 63.3 21.9 33.1	66017 19109 327 343 394 606 14160 24471 1881 1325 3070 335	46587 109312 32348 33984 39002 60014 41140 16124 1090 4731 6195 33129
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^{*} THESE ARE APPROXIMATE VALUES, AS EXPLAINED IN THE BODY OF THE PAPER

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